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Oxygen vacancy ordering in LSCO films
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Beamline(s): X14A

Introduction: LaSrCoO (LSCO) films are being used as model membranes for oxygen permeation in natural gas conversion reactors. The oxygen-deficient perovskite structure allows for fast oxygen diffusion through the film; the orientation of the oxygen-deficient planes is determined by the misfit to the substrate.

Methods and Materials: The samples were grown by sputter deposition in a mixture of argon and oxygen onto SrTiO3(001) substrates. Directly after growth at 800 C they were quenched in gaseous nitrogen to preserve the native state. A vacuum furnace with a graphite plate heater was used during the diffraction experiments. We performed truncation rod diffraction and reciprocal space mapping around asymmetrical reflections in order to monitor any structural changes during annealing.

Results: The as-grown samples showed finite thickness oscillations indicative of a coherent growth. The crystal structure is tetragonal with the out-of-plane lattice parameter being shorter than the inplane axis's a,b. Upon annealing the out-of-plane lattice parameter changes dramatically by 1% (see Fig. 2) without the loss of coherence. The change is due to the creation of oxygen vacancies and the accompanying valence change of the Co ions. The asymmetric (202) peak splits due to an orthorhombic distortion (see Fig.1).

Conclusions: The sample undergoes a structural transformation from epitaxially strained tetragonal to a twinned orthorhombic structure. The transition is not reversible under the conditions used here but very much depends on the oxygen partial pressure in the furnace.

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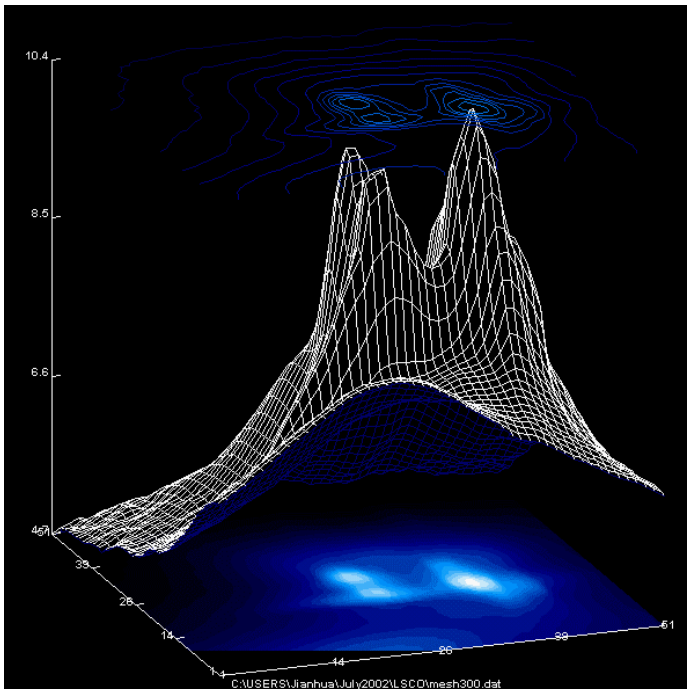

Figure 1. Reciprocal space map around the (202) reflection. The substrate peak is on the right side, the orthorhombic splitting of the film peak can be seen on the left side.

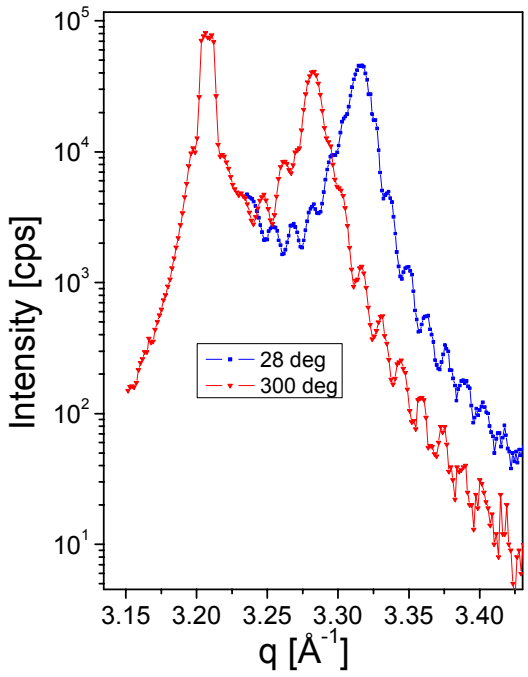

Figure 2. L-scans through the (002) reflection at two temperatures. Note the large shift of the peak relative to the substrate (left).